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I, JANENE PEISKER, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003906838 for a patent by KEVIN STEPHEN DAVIES as filed on 11 December 2003.

WITNESS my hand this
Twenty-fourth day of December 2004

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SUPPORT AND SALES

Simple Title

A control device.

Detailed Title

Machine control device using optics with infinite focal length and very long depth of field.

Initial scope of this provisional patent

This provisional patent covers an invention that may be used in other situations and for uses other than press brake control however its initial design and marketing is for press brakes where a knowledge of the shape and position of material being bent, can aid in the operation of the machinery.

Overview

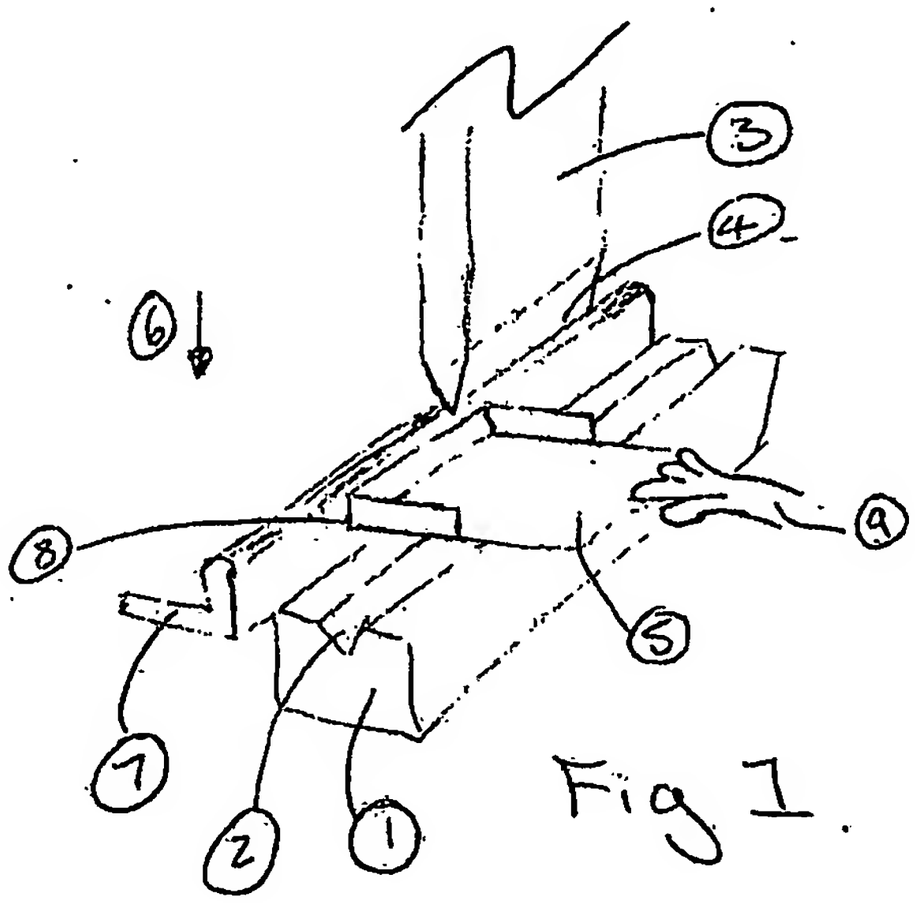

Fig 1

A typical break press has a long anvil (fig 1/1) with a VEE (fig 1/2) along the top and a blade (fig 1/3) with a leading bottom edge (fig 1/4) that fits into the VEE of the anvil. To bend a piece of sheet metal (fig 1/5), most machines drive a back gauge (fig 1/7) into a position to align the material, the material is placed across the VEE of the anvil touching the back gauge (fig 1/8). The operator then activates the break press, driving the blade down (fig 1/6) so it comes into contact with, and then bends the sheet metal that has been placed onto the VEE of the anvil.

IF the blade doesn't retract far enough then the material can be difficult to remove from the anvil.

For this reason, a press brake blade is often configured to retract to a height where material can easily be placed onto the anvil, bent and then removed again.

This opening of the blade to a preset height reduces productivity as the operator must wait for the blade to first fully retract and then approach the next piece of material that is placed onto the anvil.

Danger to the operator is also increase as a large opening exists for the operator to put fingers & hands into.

Techniques such as having a programmable blade opening height for each stage of the bending process and/or very fast approach speeds to the material (with lasers projected along the underside of the blade for safety) have been used.

However, these techniques are limited and do not solve the problem of the opening being unnecessarily large some or all of the time. Then also may result in unnecessary time being spent configuring the machine.

The present invention seeks to overcome some of all of these problems. Page 2.

The inventor

The inventor has both a science and an engineering degree and has worked for about seven years on press brake safety systems.

His first contribution is noted in provisional patent PCT/AU97/00005, where he added two parts to this patent, vibration correction by testing to ensure three lasers aligned at the same time and cross checking of the machine controller to ensure its mute point was set correctly.

His honours project for his engineering degree involved modulation techniques for projecting laser beams under a press blade and later he invented and designed portions of the Lazersafe safety system as described in international patent WO 00/67932.

He also presented a patent for a safety device in patent PCT/AU03/00707.

The Invention

The contents of patent PCT/AU03/707 are incorporated here by reference.

The preferred embodiment for the new invention consists of the following:

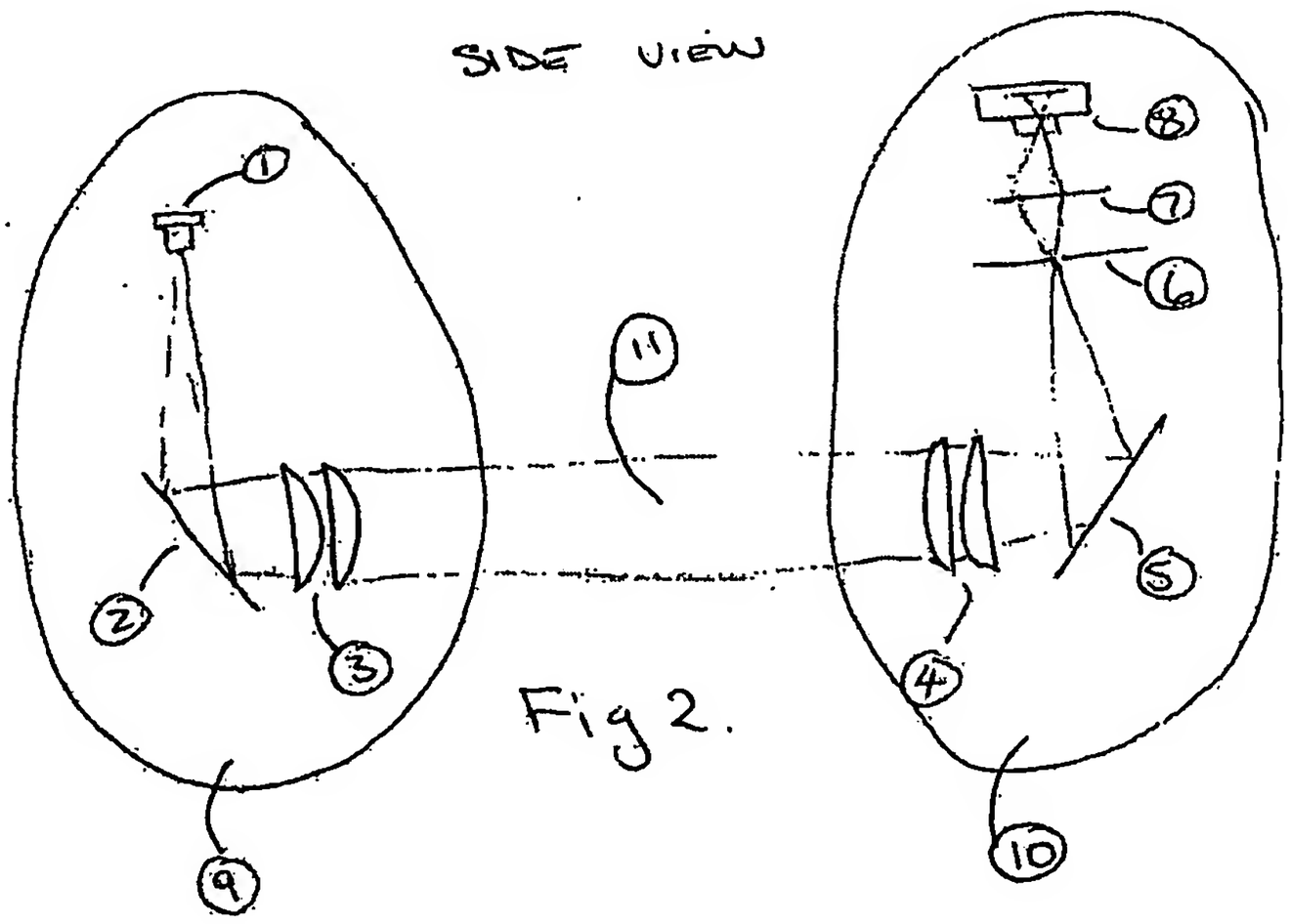

Fig 2.

A large area parallel ray light emitting means (fig 2/9) is used to illuminate the control zone (fig 2/11) so that object illuminated by the light emitting means cast a shadow. The position, speed and shape of shadows are detected by a light receiving means (fig 2/10). A control means (not shown) analyses the information from the light receiving means and controls the machine accordingly.

The light emitting means (fig 2/9) consists of a laser diode (fig 2/1) that projects its diverging laser beam onto a mirror (fig 2/2). This mirror allows a long focal length to be used without making the device overly long.
Light from the mirror is columnated by the lens arrangement (fig 2/3) that may consist of aspheric, dual plano (flat on the back) convex lenses or other suitable convering lenses. The columnated light consists of substantially parallel rays of light projected over a large area.

The light receiving means (fig 2/10) consists of a lens arrangement (fig 2/4) to converge the large area light beam and also of a mirror (fig 2/5). The converged light is passed through a pin hole (fig 2/6) and onto a projection screen (fig 2/7).
The light hitting the projection screen is detected in real time by a CCD camera (fig 2/8) and communicated to a control means (not shown).

Unlike the safety device described in patent PCT/AU03/00707, it may be necessary to keep the laser more precisely aligned with the receiver in order to accurately analyse the obstructions in the control zone (fig 2/11).

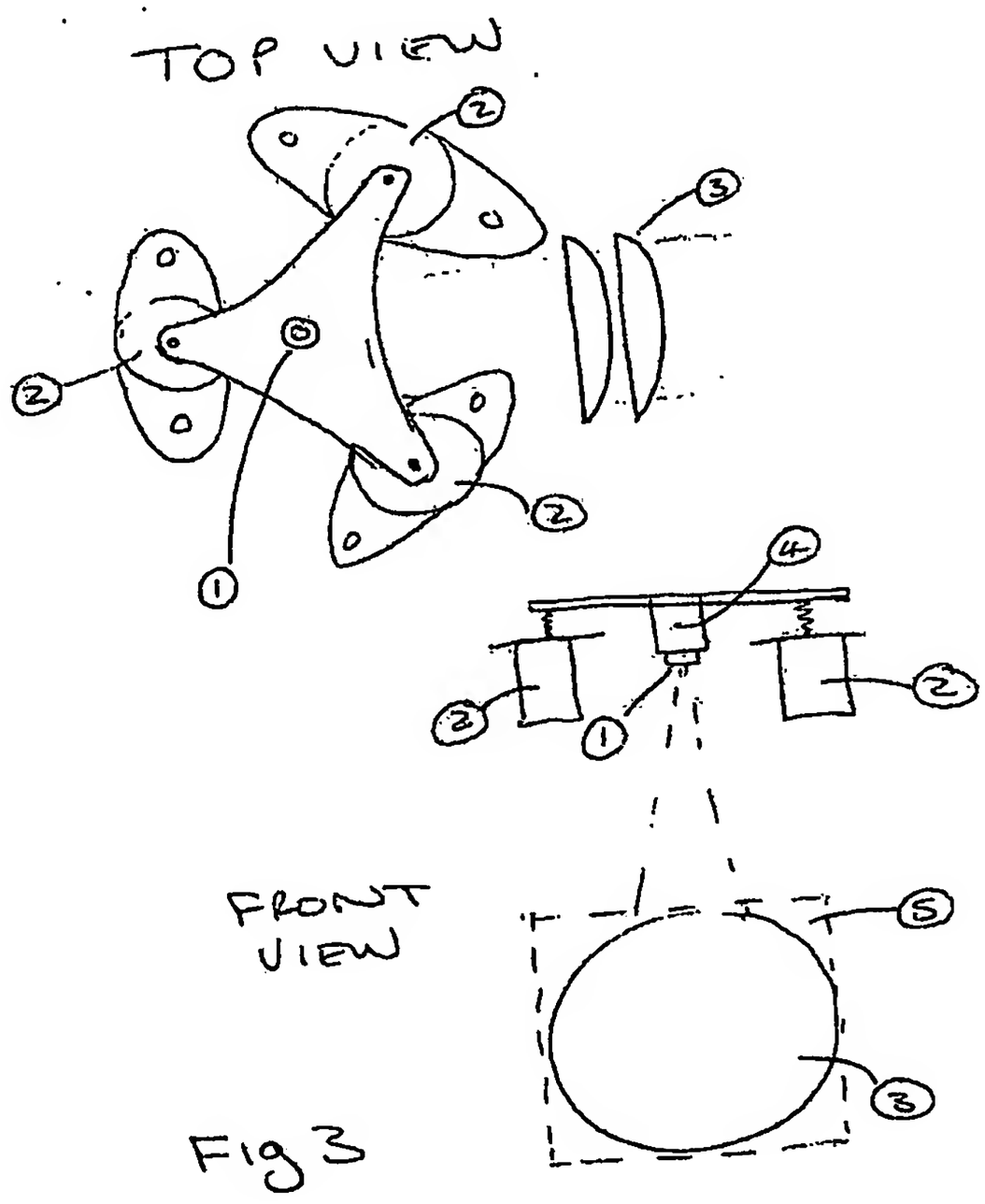

Fig 3

The preferred embodiment has a vernier adjustment to automatically alter the direction of the columnated laser beam. This is achieved by moving the laser diode (fig 3/1) relative to the lens arrangement (fig 3/3) using three linear actuators (fig 3/2).

Moving the laser diode (fig 3/1) towards or away from the lens arrangement (fig 3/3) diverges or converges the columnated laser beam. The laser can also be moved laterally by mounting the laser below the fulcrum as shown in (fig 3/4). Moving the laser diode laterally relative to the lens arrangement alters the direction of the columnated beam without appreciably altering the quality of the columnated beam.

Alternatively the mirror could be moved to re-direct (or focus) the light beam or the whole light emitting means could be directed to move the light emitting means, however, these items are heavier and are therefore by implication, more difficult to align without creating vibration problems. Also, aligning the whole light emitting means doesn't enable the divergence / convergence to be automatically altered as a separate focus would be required.

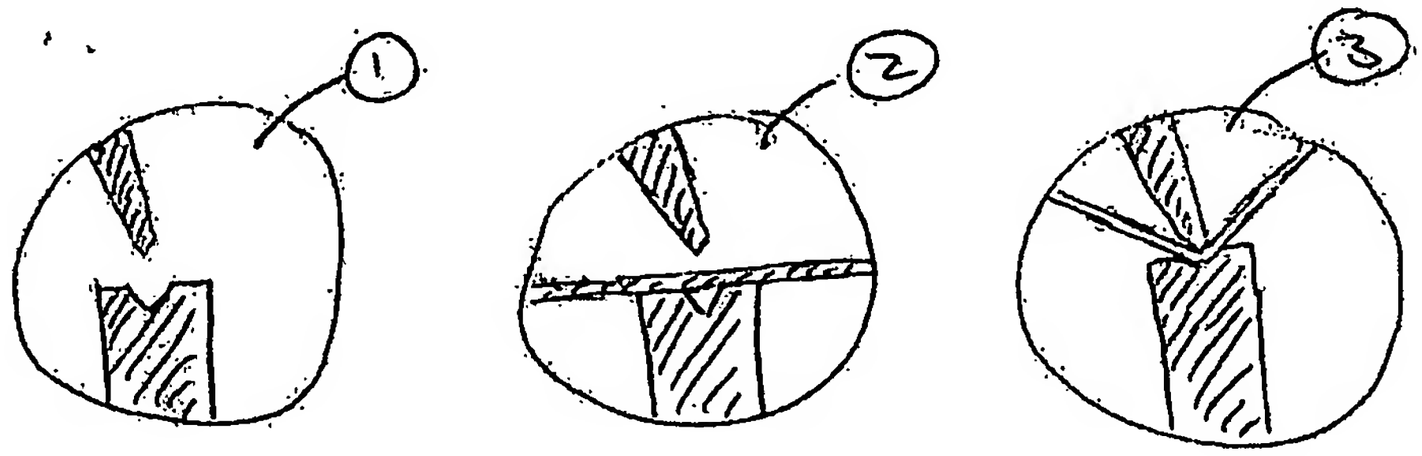

Fig 4

Fig 4 shows various images that could be analysed by the control means, these images may be:

- a blade and anvil with no material on the anvil (fig 4/1)
- a blade and anvil with material on the anvil (fig 4/2)
- a piece of material bent by the blade and anvil (fig 4/3)

The control means (not shown) consists of a programmable device (say a DSP / microprocessor or computer) that analyses images from the light receiving means and controls the machine accordingly.

Control functions include:

- Moving the blade to a suitable distance above a piece of material that is brought close to it.
- Moving the blade to keep a constant distance from the blade to the nearest obstruction while the approach switch is released.
- Controlling the speed of the blade so that it retracts faster when material is brought closer the blade and / or approaches slower when close to the material while the approach switch released.
- Stopping the machine until shortly after the material is correctly positioned while the approach switch is activated.
- Stopping the machine until fingers are moved to a safe distance from the blade while the approach switch is activated.
- Requiring the operator to release and reassert the approach switch in order to recommence blade movement.
- Analysing the bending action and stopping the machine when the required bend angle is achieved.
- Analysing the bending action and communicating bend angle information to the machine in real time.
- Using interpolation to establish what the state of any obstruction will be in at any prescribed moment.

The preferred embodyment of the control means would have three modes of operation:

1. Retract Fully. (Special 'up' swith)
2. Follow the material. (Approach sw released)
3. Bend the material. (Approach sw activated)

In the First mode, the blade would Fully retract to give Full access to the machine

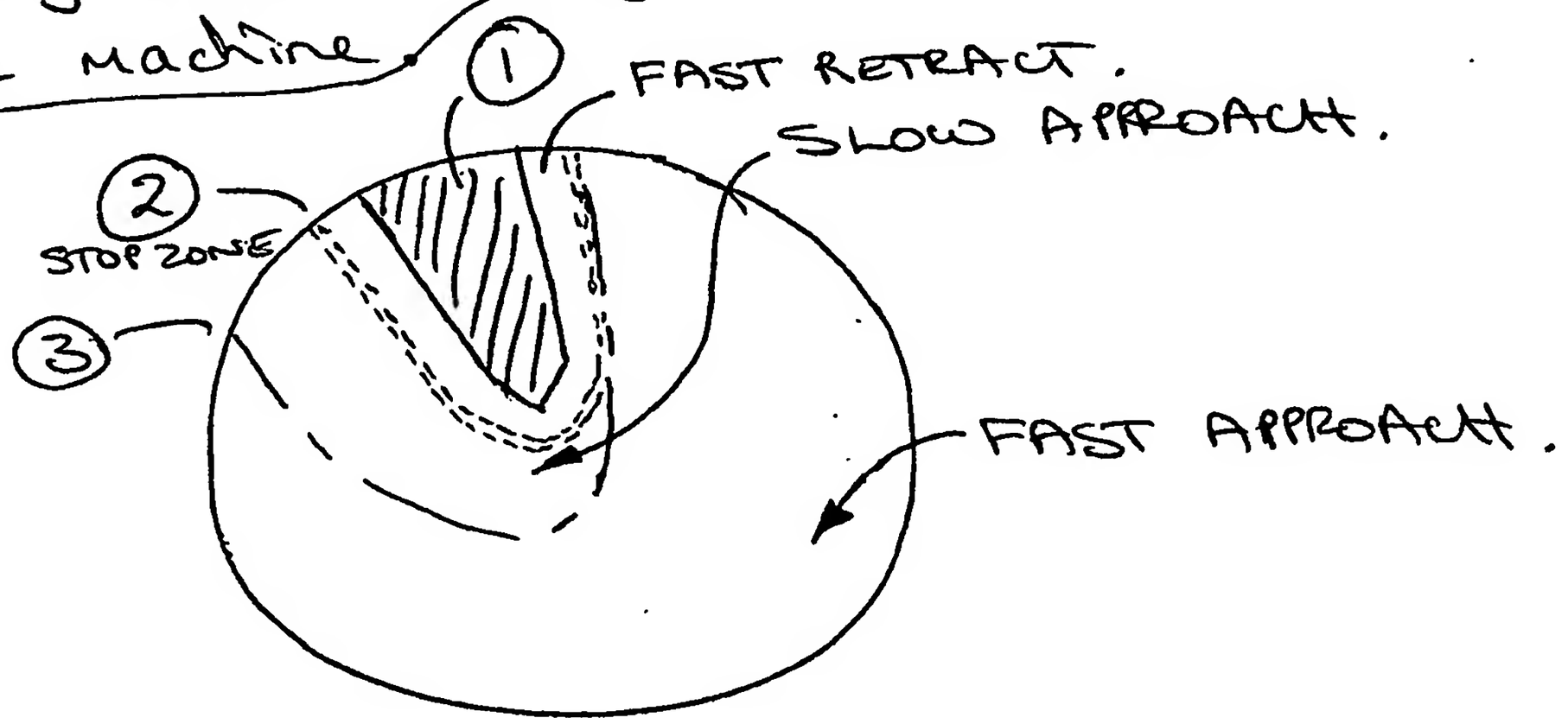

Fig 10

Fig 10 shows an image of a blade (Fig10/1) surrounded by two zones boundries (Fig10/2) and (Fig10/3)
In the 2nd mode, if no obstructions are observed inside the zone delineated by Fig10/3 then the control means drives the blade toward the anvil at high speed.

When the zone delineated by Fig 10/3 is obstructed, (Fig 11/1) the controller causes the speed to be slowed.

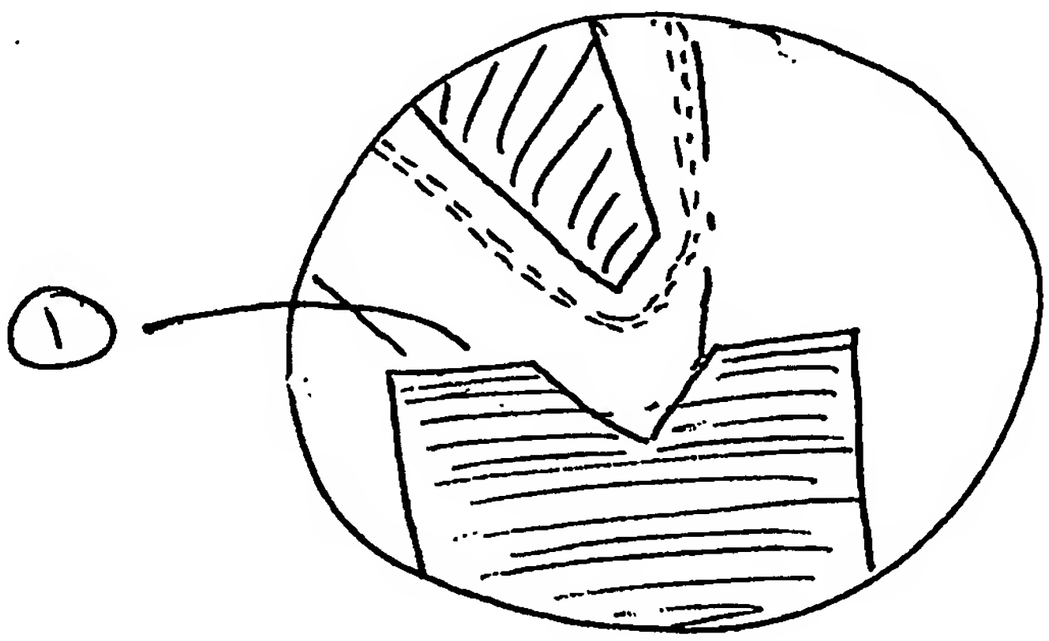

Fig 11 so it obstructs the "Fast retract" zone

IF an object is inserted after the blade has been stopped by the controller at the stop zone (Fig 10/2) Then the blade is retracted until the zone is clear (Fig 12)

Fig 12.

The blade then approaches slowly until the stop zone is obstructed.

when the operator activates the approach sw
In the 3rd mode, the control means
checks the material and only starts the
approach if the material is positioned correctly.

While bending, the control means
stops the bending action when
the prescribed bend angle is achieved.

Also, as part of PCT/AU03/00707,
the material is observed and the
press brake is stopped if a dangerous
state exists as an image does
not form part of the shadow map.

At the completion of the bending
of the material, the operator releases
the approach switch, and the
control means retracts the blade
as described in the 2nd mode
of operation.

NOTE 1: The zones shown are for reference only. The final device would have the zones configured to give the best utility. Speeds may also be dynamically changed between zones.

NOTE 2: The zones may be varied depending on the material shape being bent.

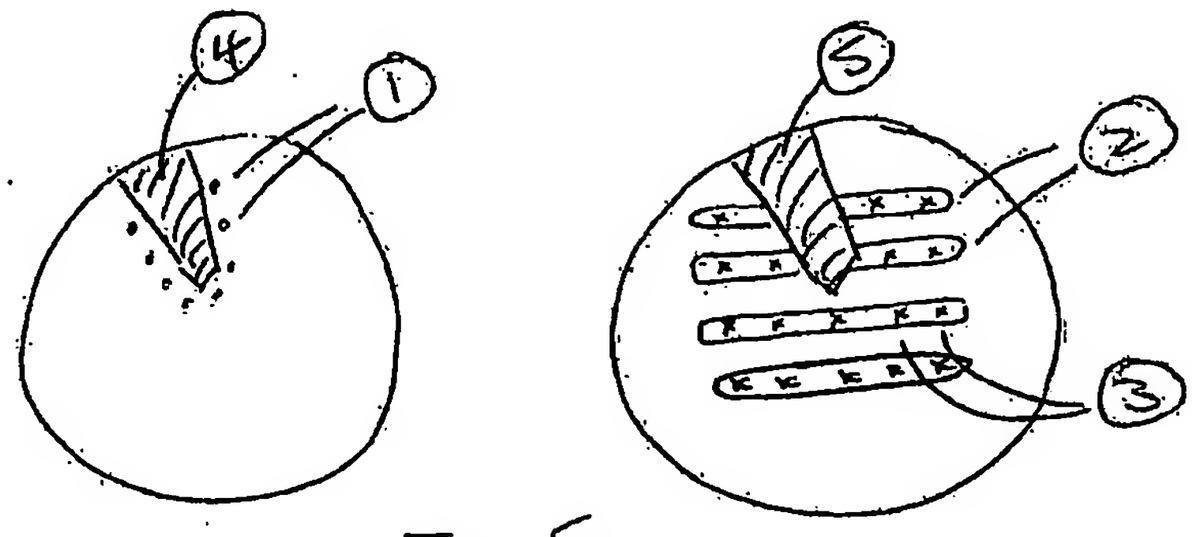

Fig 5

An alternative embodyment

of this control function is envisaged where a similar outcome is achieved by either:

projecting multiple spot laser beams (fig 5/1) at a set distance from the blade (fig 5/4) as described in WO 03/080268

or

using multiple parallel flat beam laser beams (fig 5/2) positioned one above the other with the horizontal sensors (fig 5/3) determining the edges of the blade (fig 5/5) and any material brought close to the blade.

However, this embodyment could keep the blade a set distance from the material but does not provide the same "speed" versus "distance" to blade material capabilities as the preferred embodyment.

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